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READING TECHNOLOGY.

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THE PRESENT AND FUTURE APPLICATIONS OF CERTAIN SCIENTIFIC DEVICES AND THEORIES TO INSTRUCTION IN READING ARE REVIEWED. A NUMBER OF DEVICES BASED ON COMPUTER-ASSISTED INSTRUCTION, INCLUDING THE TALKING TYPEWRITER, ORTHOGRAPHIC ARRANGEMENT, RELATIONSHIP OF WORD LENGTH AND MEANING, LETTER SEQUENCES AND THE RELATIONSHIP TO PRONUNCIATION RULES, AND PROGRAMMED MATERIALS ARE DISCUSSED. THE CURRICULAR IMPLICATIONS AND APPLICATIONS OF THE DEVICES INCLUDE THE SEQUENCE IN TEACHING PHONICS, THE CONSISTENCY OF PHONIC COMBINATIONS AND STRUCTURAL UNITS IN MATERIALS TO FORMULATE GENERALIZATIONS, THE PREPARATION OF TEXTUAL MATERIAL DEALING WITH SENTENCE PATTERNS, THE INFLUENCE OF SEMANTIC CONSTRAINTS UPON THE POSSIBILITY OF DERIVING MEANING FROM AN UNKNOWN WORD, THE PROCESSING AND RECODING OF LANGUAGE, BETTER TYPES OF READING AND PRE-READING EXPERIENCES, THE PROCESSES AND STAGES OF COMPREHENSION, READABILITY MEASURES AND FORMULAS, AND INFORMATION RETRIEVAL. REFERENCES ARE INCLUDED. (BK)

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READING TECHNOLOGY

by George D. Spache

As defined in the Webster's New Collegiate Dictionary technology is simply applied science or a technical method of achieving a practical purpose. With so broad a definition I could conceivably attempt to cover all facets of practical methods and devices in our educational system. But of course I will not. Here I shall concern myself only with a review of the present and future applications of certain scientific devices and theories to instruction in the field of reading. As you will notice, these efforts touch upon a number of facets of the reading field including curriculum, instructional materials, methodology, and analysis of the reading process itself.

A number of the applications of technology to reading involve what might be called computer-assisted instruction. I shall attempt to enumerate and describe briefly a number of these.

1. There has been experimentation under the direction of O. K. Moore with a device which translates writing or typing into sound as well as into visual symbols. The device is now available for purchase although their research with it is not very dramatic or definitive. As you recall the talking typewriter, as it is sometimes called, was used

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towards certain uses of sounds and their graphic representation. (2) Another group of studies of the letter count type is underway to determine the frequency of letter sequences or of orthographic arrangements. There are obvious implications here for instruction in spelling and in spelling rules. Hanna and Hanna have recently completed a study of this type.(6) An interesting observation coming out of these studies is that the length of word is probably one of the primary determinants of spelling difficulty not irregularity, phonemically speaking, a distinction which many linguistic phonologists might well note.

A third group of studies is underway to determine the relationship of the length of word and the breadth and depth of its meanings. Preliminary studies, for example, indicate that words of four or fewer letters are more difficult in variety of meanings than longer words. Thus it appears that length of word and perhaps irregularity, phonemically speaking, are negatively related to the difficulty of reading that word, again a finding in counterdistinction to the impressions of some linguists. These studies should help to clarify the differences between the processes of reading and spelling for those who are designing reading instructional materials based upon spelling patterns.

Other studies are attempting to determine the relationships between letter sequences and their pronunciation and the validity of the rules which have been offered for such

to introduce preschool children to the act of reading and writing with some success. In all probability a future version of this or some similar device may be used to translate sound into printed symbols. Such a translation is now possible, I understand, with the most modern computers but of course the application in the average school situation is still unrealized.

2. I need not dwell upon another large area of technological advance mainly that of programmed instructions. At the present stage of development of computer-assisted instruction with programmed materials it appears that it is possible for the training device to note the errors of the individual, to tabulate them, to chose corrective steps, and to reinstruct the student. Thus conceivably a computer could be employed in instruction in such skills as word recognition with the capacities of doing most of the instruction that a teacher might attempt.

Egocentrism also promoted a la Stanford

3. A large number of computer based studies have curricular implications. Some of these involve letter counts in a large or a small portion of our language. One type of such study might be intended to determine the redundancy of the sounds of letters and of letter combinations. There would be implications here, when a sampling is adequate, for the teaching of phonics and phonics rules. Such a study might also reveal the desirable teaching sequence in phonics instruction, as well as the true consistency of the tendencies

combinations. For example, we have assumed for a long time that a vowel-consonant combination contains a short vowel sound almost always, that a consonant-vowel-consonant combination represents a short sound in most monosyllables and polysyllablic words. Studies such as these should enable us to determine first, the redundancy of these combinations; second, the consistency; third, the implications of these facts for sequential teaching and the like.

The second large area in which computers are assisting curriculum and other educational studies are those concerned with the frequency of occurrence of sentence patterns at various ages in written material and in speech. Perhaps these studies will clarify the fact that these two media, speaking and reading, are not parallel in their use of sentence patterns or in many other ways. The assumption that reading is simply a translating of the representative graphemes and is completely analogous or based upon the oral language that the child has experienced will I think be disproven.* These studies may result in some implications for the preparation of textual materials dealing with sentence pattern. We should learn, for example, what kind of training we should give small children entering school, what other type of training might be desirable for bilingual children or foreign born or those with non-standard English. Should we provide experience in dealing with a certain group of patterns first and then later introduce others or, as the

* as an example of formulistic nonsense a la Lenzo

linguists are saying, deal with a wide variety of sentence patterns from the very beginning? These studies, of course, all depend upon a working definition of a sentence. Believe it or not, there is no uniform definition of such an utterance and various studies are approaching the study of sentence patterns with unique descriptions of a sentence. Some linguists for example consider a sentence to be everything a child says in a stream of words until he reaches an obvious juncture (or loses his breath). Others are attempting to define the phonological unit as a relatively complete utterance with the grammatical elements obviously embedded in it or attached to it. (Transformational grammar - Allen Briggs' paper)

These computer-assisted studies of language itself may well be expanded to include attempts to determine the redundancy, and the consistency of structural units such as roots and affixes. We must sooner or later learn really which are frequent, consistent in meaning, and functional in reading materials at different levels or in different subject matter areas. This type of research is essential to formulate generalizations regarding their historical development, and the spelling and the meaning changes which have occurred. Informal research has, of course, attempted to cover this but we anticipate that the computer-assisted research will give more definitive implications for curriculum planning in this area. Other studies, of course, will be necessary to determine the pragmatism of teaching these

structural units and the techniques.

Although there have been a number of such studies earlier, some of which have been reported at this conference in other years, there is the possibility that computers may be employed to determine objectively the influence of semantic constraints upon the possibility of deriving meaning of an unknown word. It may be possible to make a careful analysis of these constraints, their characteristics, and thus to make our instruction in how to derive meaning from context more realistic. If nothing else, the simulation of the process of using context may lead us to recognize what types of analysis we should be emphasizing in our instruction.

Similar studies of redundancy, structural units, sentence patterns and the like might well be undertaken in the future in the languages commonly taught in our modern language programs. Certainly this is a whole area which would lend itself to the application of some scientific facts and principles.

It is possible to simulate the development of language or the encoding-decoding process that is, to simulate thinking as it is implied in information theory, by the aid of computers. It is desirable for us to discover how an individual thinks and whether this is in keeping with any of the half-a-dozen theories of thinking that are currently offered. We should try to discover how language is processed, recoded,

chunked and the like as the information theory group suggest. There should be additional studies of the roles of semantic and syntactic words and units. Preliminary studies such as several of those offered in earlier conferences of this type have marked revelance for these approaches but probably should be supplemented by large scale studies with the aid of technological devices. An example of this type of approach is included in a recent book by Tomkins and Messick which offers chapters on the simulation of cognition, language and perception based upon computer analyses.(9) The process itself of learning to read as well as that involved in arithmetic learning may be analyzed step-by-step by computer use. Perhaps we will discover truly what is the role of letter discrimination, of word discrimination, of sound discrimination and therefore the best type of pre-reading and early reading training in these facets. We may hope to discover the nature of the reading or arithmetic learning process at different ages or stages by this type of approach. Finally we may be able to determine after the fashion of Piaget or Guilford or some others, what the process of comprehension is, what its stages are, and whether or not it is really possible to modify the strategies of thinking which characterize this obscure process. At the moment there are two recent studies which follow this particular avenue of research. One conducted by Duncan Hansen and Theodore S. Rogers at Stanford University made an analysis of the reading errors

of five year olds in an attempt to formulate programmatic steps simulating an initial reading experience.(7) A second study by Green and Henderson is adapting the O. K. Moore teaching technique in an effort to discriminate between an analytic and an synthetic approach to early word recognition. Rather than the talking typewriter reproducing a single letter when a key is depressed, the typewriter will respond with an entire word. This latter type of experience is supposed to represent the whole word approach to learning to read as these authors think we are ~~implying~~ applying it.(8)

A final illustration of the use of technological devices in advancing educational efforts is present in the study of readability measures and formulas. Danielson and Bryan have recently completed a computer count of letters, probably of word length, as a measure of readability(9) I am sure you are quite familar with the large scale study conducted by Bormuth which involved a host of measures of linguistic units by computer-assistance in the effort of testing old readability measures and evolving some new ones.(10) In the field of information retrival, education has lagged somewhat behind other professional disciplines. At the moment, however I am happy to say that it appears there will be a real effort in the application of information retrival techniques to a number of facets of education and particularly to the field of reading. An informational retrival center in the field of reading has been established by the Office of Education at

Indiana University. It will be called ERIC/CRIER which stands for Educational Research Information Center - Center for Retrival of Information and Evaluation in Reading. Drs. Ed Summers and Theodore Clymer and Leo Fay will be active in the direction of this center. Within a short time it is hoped that a large portion of the material in reading will have been abstracted, committed to the memory of computers and available for call by any of us who long to be researchers. Reproduction of abstracts by microfiche, some samples of which I have here, and by Xerox or similar reproducing devices will be possible. Thus at relatively little expense duplicates of significant research will be readily available to the reading personnel.

Perhaps we can proceed from this rather boringly long list of applications of technology to the consideration of the possible developments of the future and of some of the dangers which have been expressed regarding this development by some writers. A marked trend toward combinations of "hardware" and "software" distributors is currently visible. We see that the Columbia Broadcasting Company has acquired Holt, Rinehart and Winston; the Radio Corporation which is a part of the National Broadcasting Company has merged with Random House; International Telephone and Telegraph is attempting to purchase the American Broadcasting Company which in turn recently absorbed Howard W. Sams Publishing House. The American Book Company has been acquired by Litton Industries.

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Similarly Time, Incorporated and General Electric have purchased the old Silver Burdett Company and formed the new General Learning Corporation; Newsweek and Minnesota Mining and Manufacturing Corporation have joined forces; Sylvania, a large electronics house, has collaborated with Reader's Digest; Raytheon has purchased D. C. Heath, and finally the Xerox Corporation has combined three former educational houses including the American Education Publications, publishers of "My Weekly Reader".(4) Much of the amalgamation tendencies have arisen from the fact that the hardware manufacturers have failed to sieze the market or perhaps to realize the market for their materials which they had hoped. It is obvious that they think the new combinations of hardware plus textual and other kinds of material will be more successful. Some see some real dangers for our educational system in their suspicions of manipulation by these industrial giants. In fact at a recent congressional committee hearing some of the corporation experts testifying were asked the question whether they saw any danger to our educational system from domination by these large, powerful companies. The inquiry was never answered. The facilities as well as the large capital resources of these new combines may take either tack. It is conceivable that the hardware people will bring to us more intelligent use of such instruments as closed-circuit television, instantaneous reproduction of textual materials; less expensive computers to teach; to test and

perhaps to think for us, as well as a host of other devices. It is quite possible that these industrial managements will finally suceed in conveying an instructional systems concept to educators. By an instructional systems concept I mean an analysis of system components, a search for the most functional characteristics of the different resources which compose the school education, and the introduction of new and advanced techniques to carry out these goals. This instructional systems concept would have to consider the learner characteristics and thus have some trend towards individualized instruction as well as its obvious impact upon mass instruction. The instructional systems would certainly have to include some study of teacher characteristics, instructional methodology, as well as administrative problems. Personally, we see no great danger to the freedom of education in this introduction of advanced management and business techniques to educational work.

There is no doubt that these new developments will have a sizable effect upon educational practices no matter what form the advances take. However, there are many of us who are quite cognizant of the slowness of educational change. A quotation on this by Paul R. Hort is quite appropriate. (5)

> "After an invention which is destined to spread throughout the school appears, fifteen years elapse before it is found in three percent of the school systems. .... an additional twenty years usually suffices for an almost complete diffusion in the area the size of an average state. There are indications that the rate of

> spread throughout the nation is not much slower .... school systems do not seem to be geared to the fact that the knowledge of available inventions is necessary if they are to improve and that the individuals operating the schools must master this knowledge."

There is certainly a tremendous inertia in the development of new advances in techniques in our educational systems. Think for a moment, if you will, of what was probably the first technological device used in our American schools, the Hornbook. The use of this began earlier than anyone's record seem to be able to establish and persisted thorough the 18th century long after other instructional materials were readily available. Perhaps one of the reasons for the persistence of this first technological instrument was the fact that some versions were made in gingerbread and thus could be consumed as a reward for successful naming of the letters of the alphabet. Apparently the concept of immediate reinforcement in a concrete fashion is not a new one. However, some undoubtedly fear that our educational system will become a technocracy, a society ruled by technicians. Mort's observations regarding the speed of adoption of new devices in schools probably indicate that the impact of the new technology is not likely to result in a technocratic takeover of education by the "hardware" and "software" combines.

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